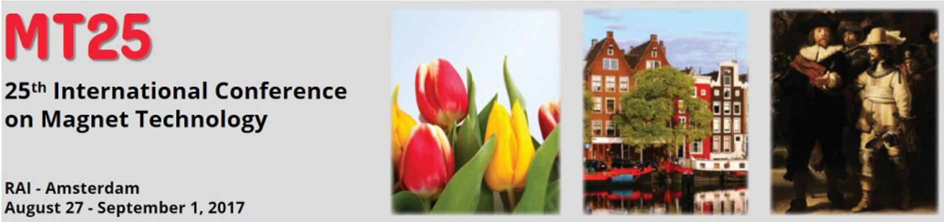

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Self-heating effect in HTS coils

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A straightforward analytical model is presented that describes the observed slow thermal drift of the conduction-cooled ReBCO coils developed for the EcoSwing project. In the vicinity of their critical surface, both the temperature and the voltage across these coils drift upwards in response to a current step, on a time-scale ranging from minutes to hours. Eventually, such drift results either in a quench or a new equilibrium temperature. EcoSwing aims to demonstrate the world's first superconducting low-cost, light-weight wind turbine drivetrain. In order to validate the rotor pole design, THEVA produced a series of sub-scale test-poles which reflect the actual layout of the full-scale poles. Several of these sub-scale coils were tested at the University of Twente in terms of superconducting behavior and thermal housekeeping. The voltages across the coils were measured over time at various current levels and base temperatures ranging from 55K-77K. To explore the thermal drift effect described above, an analytical model was devised based on self-heating of the winding pack. The model, which essentially combines a simple heat-balance equation with a non-linear power term, shows how the detailed ratio between initial heating and cooling leads to two sharply separated types of eventual outcome, either stable or unstable. The heat capacity of the coil does not influence this outcome, although it does determine the time scale. Model predictions were compared to experimental data, showing excellent qualitative and relatively good quantitative agreement. As such, the model provides a better understanding in the thermal behavior of conduction-cooled HTS coils and may be used to guide their design. EcoSwing has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No656024. Herein we reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

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